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ABSTRACT

A conference on science and technology and future human needs was attended by over 300 science educators from 64 countries. Educators with particular interest in primary science and technology education extended their stay for an additional seminar. This report highlights the events of that seminar. Contents include: (1) recent and on-going work in primary science by international organizations (reviewing programs of the International Council of Scientific Unions, UNESCO, and the International Council of Associations for Science Education); (2) workshop events (summarizing topic group reports on the environment; food and agriculture; industry and technology; energy, land, water and mineral resources; health; information technology; and ethics and social responsibility); (3) workshop products (providing ideas on inservice experiences, program construction, and a suitable climate for primary science); and (4) future considerations (identifying educational needs and goals). Appendices include a participant list and examples of student activities. (ML)

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BANGALORE CONFERENCE REPORT

An International Workshop on Primary Science

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Report on the primary science workshop held after the Conference in Science and Technology Education and Future Human Needs Bangalore, August 1985.

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An International Workshop
on
Primary Science

Report compiled and edited by

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An International Workshop on Primary Science

Report on a one and a half day event held in Bangalore, India, August 1985

Report compiled by
Wynne Harlen

1. Introduction

In August 1985 over 300 science educators from 64 countries came together in Bangalore, India, for a conference on Science and Technology Education and Future Human Needs. Their concerns ranged from primary through to tertiary and adult and community education, all of which were encompassed in the conference. Those with particular interest in primary science and technology education took the opportunity to stay in Bangalore for an extra one and a half days for a short seminar (a mini-workshop); this is a brief report of the events packed into those hectic hours.

The primary science workshop was made possible by additional funds provided by UNESCO and by the sponsors of the main conference, particularly the International Council of Scientific Unions (ICSU), the United Nations University, the World Federation of Engineering Organisations, the British Council and the ICSU Committee on Science and Technology in Developing Countries. The organising committee is also grateful to the International Council of Associations of Science Education (ICASE) for providing support for the typesetting of this report, to the Association for Science Education in the UK for printing it and to UNESCO for distributing it. The primary science workshop was planned by a small team, named in Appendix A, which also gives the list of participants and names of those who expressed interest but for one reason or another were prevented from attending.

The programme was designed to provide opportunity for

- bringing together the points relevant to primary work emerging from the main conference,
- working towards a shared understanding of the kind of learning and the kind of learning activities which constitute good practice in teaching science and technology at the primary level,
- identifying and discussing the main issues felt by participants to

be most in need of attention, with the particular problems of third world countries in mind (although in many respects all countries were thought to be under-developed in relation to primary science),

- exchanging ideas and making recommendations which might help progress in improving primary science and technology education worldwide.

Given the international context of the workshop it was appropriate to begin by reviewing briefly the recent work of international organisations in primary science education and to end by making some recommendations for further support at the international level. This report will also begin and end in this way. In between there are short accounts of the workshop transactions and the products of the working sessions.

2. Recent and on-going work in Primary Science by International Organisations

International Council of Scientific Unions (ICSU)

In 1968, ICSU created its Committee on the Teaching of Science (CTS) which has various sub-committees. A small sub-committee of CTS on the teaching of elementary science was created in 1981. Members have been able to meet on three occasions but much work has been done by correspondence. An early decision was to focus on teacher-training and to develop a programme involving working at primary science in workshops and the exchange of teacher training materials for the improvement of primary teacher education in science both at pre-service and in-service levels.

The first product of the sub-committee (when its membership was only three) was the publication entitled *The Training of Primary Science Educators - a Workshop Approach* which was published by UNESCO as number 13 in its Document Series (hereafter referred to as Document 13). The second work of the sub-committee (its membership then reduced to two) was the current mini-workshop. The third venture, still being planned with help from UNESCO, is a more extended workshop in teacher-training, to be held sometime in 1986 or '87.

UNESCO

UNESCO's programme in primary school science education is aimed broadly at three categories of people:

1. Those in decision making positions in educational systems.

2. Those concerned with teacher-training, curriculum development and other key aspects of science education.
3. Practising teachers (who may also be involved in the work of curriculum development).

In 1984, an International Conference of Ministers of Education was held in Geneva on the subject of primary school education. Science in primary schools formed one of the major topics of discussion and a special Recommendation was made concerning science in primary schools.

A series of activities has been held for key personnel in primary school science education. These have included an international meeting of experts on the subject leading to the publication of *New Trends on Primary School Science Education*.[1] The present workshop has received support from UNESCO, as has the preparation and publication of Document 13 on which part of it is based. Regional and sub-regional training workshops have also been held for key personnel in this field.

Publications have also been produced for the use of practising teachers on topics for, and methodology of, primary school science education. Resource material has also been produced on low-cost equipment for use in primary schools, and a project on toys and games is in operation.

At the national level, UNESCO has provided assistance, both technical and financial, to Member States, at their request. This has included sending advisory personnel, supporting curriculum development projects, training workshops and the production of low-cost equipment.

An international primary science education workshop will be held during the 1985-86 biennium, continued support will be given to the activities in this field of ICASE and the CTS sub-committee and further publications, training workshops and other projects are planned.

International Council of Associations for Science Education (ICASE)

Complementing the activities of the other two organisations above, ICASE has focused on developing classroom materials to supplement those at present available. The materials are entitled Science for Life and a list of topics being developed are included in Appendix B. The main features of the materials being produced are:

- They are designed for primary school children in developing countries.

- They are geared towards the application of science to human problems, viz health, food, environment, shelter etc.
- They are produced very simply and are easily adaptable to various languages and situations.
- They are built around the use of low-cost, readily-available materials.

There are three different types of materials:

(a) Student lessons — simply presented, liberally illustrated.
(b) Equipment book — plastic pre-formed bound sheets which contain scientific supplies and equipment that can be cut out, assembled and used with experiments. This book has no printing, thus facilitating mass production of the various moulds and use in any country without translation.
(c) Teacher leaflets — instructions for the teacher on how to use the lessons.

The materials are produced at various levels called first science, second science, third science etc. No age levels are prescribed since countries start primary science at different age levels.

The materials are currently in draft form. It is the intention that ICASE Member Associations will participate in the translation, trial, adaptation and eventual distribution and the materials.

Other Initiatives

Information was given about a project funded by CARE in Kenya and Uganda which produces comic-type magazines giving information about environment and health care to children and their teachers (see Appendix G).

3. The Workshop Events

During brief introductory remarks, the following points were made:

- the tangible product, this report, would be only one outcome of the workshop; the process of participation and interaction was itself an important outcome for those involved;
- the 'working document' for the workshop was Document 13, which had been distributed to all participants;
- a 'workshop approach' had a particular meaning which the workshop can exemplify only to a limited degree due to shortage of time; it emphasises the value of involving teachers and other educators in the feel, or the experience, of activities which could serve as a model for the classroom;

- the meaning of 'primary' assumed in the workshop was that proposed in *New Trends in Primary School Science Education*; i.e., 'the first eight years of education, during which science was generally, though not invariably, thought of as a unified subject. Throughout those eight years, the nature and organisation of science changes from being integrated with other learning, in the first two or three years, to becoming a subject on its own, often taught by a science specialist, in the later years' (UNESCO 1983 p.188)

Reports from the main conference

The work of the main conference was planned around eight topics related to human needs, the purpose of the groups working on each being to examine the ways in which science and technology education could be made more relevant to the needs of society. The full report on each topic takes the form of a book published by the ICSU Press and includes material relating to all levels of education. It was felt useful, however, to bring together reports of the primary level work at the beginning of the workshop. The results are summarised below.

Environment

The deep interest of this topic group in primary science was indicated by devoting two sessions to it, involving working with children from an Indian School. The themes that were present in several of the discussions were:

1. environmental education in school and in the community,
2. the place of environment education in science teaching.

One aspect that was stressed is the need to encourage a holistic approach to Environmental Education including such other aspects as arts, social sciences, etc with science.

It was agreed that schools should establish links with the community in the environment of the school through an issues based approach. There was concern, however, for more investigation and guidance in how to implement innovative programmes in primary schools.

Food and Agriculture

The main sub-topics of this topic that were directly related to primary education were nutrition, growing food and storing food. In discussion of appropriate teaching methods emphasis was placed on children directly confronting real foodstuff taken from their

environment. This 'confrontation' becomes science by posing relevant problems and encouraging the children to ask their own questions, then helping the children to find the answers through working with the real things by observing, predicting, experimenting — in other words all the skills necessary to 'ask the foodstuffs' (see page 10). Activities exemplifying this type of work were produced for the sub-topic on preservation of food and are reproduced in Appendix C.

Industry and Technology

In relation to links between primary schools and industry, there had been a session in which examples (on video-tape and slides) had been shown of primary children in Indonesia undertaking topic-based work involving a study of local industry. The children had been defining their own questions, collecting information using process skills and using materials and information collected during visits to a tea factory and a rabbit farm. Members of the group subsequently discussed visits to small local industries, suitable for young children to visit (a bakery, a printing house etc.) and drew up outline plans of possible work, mentioning the cognitive skills, attitudes, knowledge and social learning which could be pursued through it. It had been agreed as important that industry should be included in children's early study as part of a 'life experience' curriculum. In arranging such work it was useful to have a 'catalyst', a person outside both school and industry, to help bring the two together (a teacher educator or local authority adviser could take this role) and to help relate certain aspects of industry to science topics and to communicate with other teachers and primary educators in a co-ordinated approach to topic work.

It was suggested that work in technology could be initiated with primary children by posing a problem, supplying materials and allowing the children to work on their own ideas. It was acknowledged that there was a need for ideas for simple projects and for guidelines for teachers working with children in such projects.

Energy Resources

It was recognised that energy was a difficult concept and that most work concerning renewable and non-renewable energy resources, cost and efficiency in using energy, etc. were most appropriate at the secondary and tertiary levels than at primary level. However, it was recognised that in many countries the education of the majority of children does not extend beyond the primary level. As energy is a world resource, it was thought vital that

awareness be included in the primary curriculum. This required, among other things, assistance for teaching in the form of:

- operational examples of the concept of energy through simple everyday concrete experiences,
- suitable practical examples for children using simple materials,
- guidance in identifying the relevant energy conversions.

In these activities the enquiry approach should be used and the children encouraged to use and develop their abilities to observe, predict, measure, interpret, etc. Science through enquiry implies the work ASK. It is appropriate that, in the English Language, this word is an acronym for

Attitudes
Skills
Knowledge

and this is the order of priority to which we should address our efforts.

An example of an energy activity suitable for primary children is given in Appendix D.

Land, Water and Mineral Resources

Two of the units of work developed were especially relevant at the the primary level:

1. Unit on Water and Health
   - The aim of the unit was to create an understanding of the relationship between water supply and health and the importance of sanitation and hygiene through activities.
   - The unit includes
     (a) experience with the immediate environment,
     (b) data collection from observation and measurement,
     (c) integrating the issue with other subject areas.
2. Soils and land
   - The main emphasis was on observing, manipulating variables and recording data.
   - Some issues dealt with in the section on erosion were applicable at the primary level.

Health

There were two major aspects of the workshop having relevance to primary science education.

1. Already traditional health education topics treat many

problems leading right into the centre of primary science, because they concern the pupils' environment and their understanding of it, and the development of skills to run their daily life. Such topics include hygiene, sanitation, nutrition, sex education etc. A new aspect was the emphasis on the strong connections between health and the quality of the environment. Special interest was attached to diseases of global importance. The working group elaborated an educational approach towards this problem, covering the whole curriculum. For primary education a case study approach was suggested, studying single examples of diseases and linking them, as a kind of life management, to the general problems of health education.

2. The global aim of the Health Group's work was to instill a **positive** approach to health, as a concept not just contrasted with disease, but as a value of its own, and a part of a holistic concept of quality of life. The relevance for primary education of this approach might be seen particularly in giving a basic trust in life. The development of this might well be prevented by an education that over-emphasizes the endangered or ruined quality of the environment. Primary education should stress experience of the intact environment, its character in providing a basis of our lives, and its beauty. Practical work should be done on problems where pupils really can do or change something, and which show the network of inter-relationships in the environment. This would be an educational argument to preserve an intact environment so that children may experience it their way, learning by just taking part in it. Within this general concept there was emphasis on the social and cultural basis of health, especially as a condition of mental and social health. Relevance for primary science, would be to study the objects in children's experience not as if they just existed on their own, but as things produced and/or changed by human activity during history, embodying heritage and cultural indentity.

Information Technology

The group had explored a wide range of means of communicating information from words, signs and symbols to video recording and microcomputers. A theme throughout had been appropriateness, the importance of selecting the form of transfer which gave the most useful information with as little distortion as possible.

Where feasible, new technology would be used to widen

children's experience and awareness of issues (e.g. a tape-slide presentation on conservation and a computer simulation about malaria had been presented). At the other end of the technology scale, were examples of cartoons and stick-figure drawings which communicated matters of local concern across language barriers.

Ethics and Social Responsibility

This group was, by its terms of reference, concerned with all topics and thus its work brought together and reinforced messages for primary education from other groups. A number of examples were discussed of ethical issues relevant at the primary school level. It was felt that it was important to develop good habits and attitudes as early as possible in relation to health, food and the local environment. Children's attitudes to animals were also discussed. It was felt that children should have developed the following attitudes towards science and technology by the end of primary schooling:

1. Confidence in their own ability to ask questions and discover satisfactory answers about the world around them.
2. An imaginative readiness to tackle problems which they encounter and to respond to them with innovative and feasible hypotheses.
3. A methodical attitude to the process of inquiry, interpretation and reporting.
4. An appreciation of the advantages of working co-operatively in posing questions and pursuing enquiry.
5. A respect for objectivity in reasoning and assessing information.

The following attitudes towards society and nature resulting from an education in science were also felt by the group to be important, and to be fostered during primary schooling:

1. A curiosity about the world about them and an eagerness to learn more about it.
2. A sense of wonder for the phenomena which science has uncovered for them.
3. A respect for the nature of phenomena and the inter-relationship of time, order, ecological balance, life cycles.
4. A sense of the fragility and limitation of the world's resources and their relationship to human consumption.
5. An environmental concern and a sense of responsibility of humanity towards its care.

Workshop experience

> 'Ideally, then, children are placed in a problem situation, surrounded by suitable and appropriate materials, and they are not given answers. They may be shown the way towards a satisfactory solution; they will be encouraged to explore. The answers they seek are hidden in the things which they are allowed to handle, to manipulate, to experience. If they are given anything, it will be the right question at the right time. The searching for and the finding of a solution are activities they have to do themselves. They have to puzzle themselves, to experiment themselves, to reason themselves, to make mistakes themselves, and to find the way out of those mistakes themselves by reconsidering the evidence which led to their faulty conclusions.'
>
> UNESCO 1985 p.14

Following reports from the main conference in the initial introductory session, there was a more active period for workshop participants. It was a period with its own message; afterwards there was opportunity to sit and discuss and reflect on the message.

The message

- Science takes place when children seek answers to questions by direct interaction with real things,
- whilst words are important in science education, the impulse 'to tell them' has to be resisted by teachers,
- of *primary* importance in primary science is the encounter of children with real things and the dialogue they have with these things when, through actions, they 'ask the objects' and find out the answers from them,
- the nature of the encounter, dialogue and interaction cannot be conveyed adequately by words; it has to be experienced.

The experience

A range of 'starters' for interaction was provided for participants to embark on the encounter and dialogue with things for themselves. There were too many for anyone to try them all, but they were written on sheets, next to the basic materials required so that people could select one, or perhaps two, for there was no time for more to be undertaken seriously. In this way participants had chance for an encounter with a real animal, a real plant or a real thing.

All the objects used, living and non-living, were found in the grounds or building of the conference venue. Many people found it

necessary, to answer their questions, to go into the grounds to seek the *mimosa pudica* or the *antlions* where they were living naturally, whilst others used the specimens already collected and temporarily housed indoors.

The sheets used to suggest activities were described as 'starters'; they were not worksheets to be filled in. Any instructions they contained were instructions to observe, to question, to hypothesise, to try out ideas... Appendix E shows a selection of them.

During this practical session the opportunity was taken to introduce a more directed activity, especially important to health education in developing countries. ('Origami and oral rehydration' is reproduced in Appendix F)

The reflection

In discussion of the problems of implementing science in the form of activities such as the ones experienced, the main issues concerned progression, the teacher's role, the provision of materials and structure in activities. The main points can only be summarised:

PROGRESSION

- The interaction (the questioning, the investigating, the observing) becomes more and more sophisticated as children grow in capability and experience. The process takes place as the first sample experiences (illustrated by a question describing a very young boy exploring water bubbling in and out of holes on a beach[2]) are brought together into more complicated ideas.
- The patterns linking these experiences are the basis of concepts, which are abstractions, enabling children to use a wider range of resources than 'the real thing'. They will then be able to use words which stand for the concepts with a firm grasp of the collection of real experiences, things and events, which these words evoke. This ability gives access to the use of written sources of information and to making sense of verbal explanations.
- At the same time more relationships are seen and existing ideas can be linked to new experiences, helping in the process of making sense of them.
- Some attempts have been made to describe the development of process skills, concepts and attitudes of science more fully[3] and it is the responsibility of the teacher to become familiar with the development so that he/she can discuss the point reached by a child and the best next step to be taken.

THE TEACHER'S ROLE

- Far from being a matter of supplying materials and letting the children get on with it, the teacher's role is one of carefully planning the materials, organisation, time and his/her own interaction to enable children to interact productively with things from the environment.[4]
- The materials have to be chosen carefully, with the children's experience and capabilities in mind.
- The class organisation has to allow children in groups to come into productive interaction with the materials.
- There has to be a structure to the encounter so that there is interaction between children and materials and between child and child.
- The teacher's questions have to be carefully chosen (see 'The right question at the right time'[5]) and generally 'open' and 'person-centred' questions.[6]
- To give children access to a range of ideas about the objects of their study, the organisation and resources should enable children to use ideas from:

  other children
  the teacher
  displays
  books

  and, where appropriate, from visits, visitors and the media.
- The time required for interaction and discussion is much more than is generally thought at first; teachers must arrange for the necessary time to be available, or children's interactions will be superficial and unsatisfying.
- Part of the role of the teacher is to make time to listen to children's ideas and to observe the way they go about their investigations. This is essential for finding out about children's progress in the skills, concepts and attitudes which can be fostered through their activities.

PROVISION OF MATERIALS

- The amount of specialised equipment required for primary science activities is not large and many activities can be done without any at all (for example all those in Appendix E).
- Once teachers realise that everyday materials can serve to support many (though not all) activities, a useful start is to ask the question—

  What do we have?
  What science can be done with it?

- When existing materials and equipment fall short of requirements, there are further questions —

  What can we find?
  (from the grounds of the school, from nearby fields, buildings etc)
  What can we scrounge?
  (empty containers of all kinds from parents, shops, cafés, etc)
  What can we pinch?
  (things people don't know they have)
  What can we pay for?
  (the specialised items)

- When money is available it is best to reserve it for those items which cannot be substituted by everyday materials. The use of 'homely' items where possible (as containers, for example) is preferable to the use of laboratory-type equipment, since the latter can stand in between the children and the phenomenon being studied and turn science into a subject that has little relation to everyday reality. Available money should be used for equipment which enlarges the observational capabilities of the children, such as hand lenses, measuring instruments, balances.

STRUCTURE AND SEQUENCE OF ACTIVITIES

- There is a balance to be struck between 'open-ended' activities in which children's ideas lead from one point to another and a pre-planned sequence of activities. A useful compromise is for the teacher to introduce the topic, in a manner which acknowledges the children's experience and interests relating to it, and to encourage children's initiative, within the topic, to investigate and develop and test ideas in their own way.
- The sequence of activities is not so much determined by the topic as by the treatment of it. Most topics can be pursued, in some way, through either concrete experiences or through some abstract approaches. The treatment chosen should depend on the children's ability to respond to abstraction, remembering that there is some degree of abstraction in every communication involving words.
- The science concepts we want children to develop are abstractions which children should be helped to arrive at for themselves on the basis of their experience. Hence plenty of concrete exploration and manipulation is a prerequisite. Eventually, research may identify well defined levels of concepts

which will guide the sequence of topics through which these concepts may be built up.

Facing the issues

In a short, and fairly sharp, brain-storming session, groups listed what they thought were the main issues to be faced in primary school science and technology education. These issues were then brought together in one list and attempts made to classify them. After trying unsuccessfully various bases for classification it was agreed that the issues were best divided into two groups which are given the titles of 'philosophical' and 'implementation' issues.

Philosophical

- What is learning science?
- Why should the particular kind of learning in science discussed in the workshop be adopted?
- Should science be a distinct study or integrated with other subjects of the curriculum?
- What can be done about the cultural clashes that raising questions and being independent in thinking may create?
- What evidence is there that science in the primary curriculum is worthwhile/successful?
- What content and what concepts are appropriate at the primary level?
- What can science teaching at this level contribute to the problems of meeting human needs?

Implementation

- What degree of structure should there be in the primary science syllabus?
- What structure is required to support and supervise science teaching in primary schools?
- What can be done about implementation in under-resourced conditions?
- How can guidelines be given for making the best use of the local environment/resources/community?
- What is the most effective form of in-service education?
- How can teachers find time to teach science in the way which the workshop has suggested?
- How is primary school science to be evaluated?

Of course it is not too difficult to ask questions but these lists emphasise how much there is still to be found out, tried out and evaluated in primary science.

Participants divided themselves into two groups to work on each of these sets of issues, but of course could only begin to scratch the surface of a few of them. The products can convey little of the interchange of ideas, discussion of conflicting views and insights achieved by those involved in reaching them. The value was in the process, in which participants clarified their own views through expressing them and through listening to others. This is the nature of a workshop.

4. Workshop Products

In-service experience

The group exercising their thinking and pooling their experience about implementation issues focused on the nature of, and strategies for, in-service work. In the short time available ideas were not woven into a whole fabric but had to be left as separate threads. On the assumption that others may pick up these threads and find them useful, they appear in the flow diagram and notes in the following pages.

1. Participation

Many contributors agreed their experience showed results of in-service activities to be most long-lasting where participants were self-selected. However, this tends to leave out large numbers of teachers who may profit from assistance.
The number of teachers participating 'voluntarily' may be increased by offering:

- diplomas, certificates, & other career incentives,
- courses for administrators/head teachers, which then produce support within the school for new work;
- a visible 'product' of the course — e.g. practical teaching materials;
- convenient times for meetings;
- 'whole staff' courses tailored to the needs of a particular school;
- help for teachers who attend courses on how to encourage and work with other teachers;
- building courses around the 'felt needs' of groups of teachers;
- encouraging teachers to help in planning courses.

In Hong Kong and in U.K. the strategy has been used of having teachers who are members of active groups (e.g. Hong Kong Science and Maths. Assoc.) 'chat' with colleagues in school to

- identify interests
- help develop interests

which could be the basis of in-service work.

Participants who self-select may be keen, experienced and confident. This may be an advantage if they are later to work as 'key' teachers.

2. Development of Courses/Patterns of Work

- Offered by 'experts' —
  Resource Centres
  Teacher's Centres
  Training Colleges
  Advisers, Supervisors, etc
  University Education Depts
  either for volunteers or as part of a structured career advancement
- Developed by 'experts' based on what they perceive as 'The Felt Needs' of groups of teachers
  - in a particular school
  - in an area
- Self-help by groups of teachers
  - following a course or workshop
  - through meeting at some 'centre'

3. Continued enthusiasm is promoted by *continuing opportunities* for teachers who have been on courses *to meet* with each other and share ideas and materials.

This can be aided by:

- several teachers from one school attending courses together;
- follow-up meetings at regular intervals after the main course has finished;
- provision of 'Teachers' Clubs' or other meeting places where teachers can contact each other easily and regularly;
- 'sandwich' courses, where trying out materials and meeting to discuss the results are built into the in-service work;
- visits to schools by an adviser/supervisor/facilitator who helps teachers keep in touch;
- 'self-help' groups among teachers where materials and equipment are developed and shared.

4. Head Teachers, advisers, and administrators can be invited to join workshops.

Where 'higher-ups' understand and feel connected with new work, it seems more likely to succeed and 'key' teachers find it easier to spread innovation.

The 'felt needs' of teachers are springboards for new work if the teachers can be helped to see that the new methods will help fill that need. Later, they may expand the work on their own initiative.

Role of Training College & University can be expanded from concern with initial training to IT-INSET — a co-operation between serving teachers, teacher trainers and teacher trainees.

5. Support for innovation and development can come from sources *outside* the formal education system.

e.g. Singapore Science Centre offers
- short courses
- topical workshops

for which teachers can apply

The Teachers' Centre in Bombay offers courses given by active scientists and other non-teacher experts.

Local experts and resources may be found within the community to broaden teachers' experience and understanding.

Local issues & resources can be used by teachers in schools.
To do this well, teachers may need
- an open mind, to see opportunities
- assistance, e.g. with supporting materials, from adviser or teachers' centre.

6. A consultant's role

One approach in in-service work is working together with the teacher in her/his *own* classroom with the children. This is *NOT* a demonstration; the local teacher remains in charge, but *together* they interact with the *common* experience for further discussion and planning.

In Tasmania, a consultant visits schools and identifies two teachers who are invited to an activity-based workshop for 20-30 teachers. On return to their school the two teachers discuss with the other staff and invite the consultant to the school to lead a school-based seminar leading to the development of the school's own science programme. Teachers feel a commitment to this document and work to it.

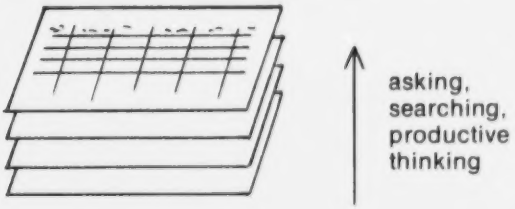
7. Materials for new work may be important to teachers as support for innovation.
- as a visible 'outcome' after attending a course;
- materials from a teachers' advisory/resource centre can help in application of new ideas in particular schools;
- meetings to continue development of materials may provide a valuable point of exchange of ideas and enthusiasm for teachers (e.g. Indonesian 'Teachers Club');
- materials offer a vehicle for discussing new approaches with colleagues;
- some materials can fill a 'felt need' of teachers and *also* introduce new ideas — e.g. reading materials with a science/environmental content, where the demand is for reading materials.
  (e.g. 'Child-to-Child' materials from TALC involve reading materials for children with
  - health content related to life issues
  - a new way of teaching).

Programme construction — development and integration

The group concerned with philosophical issues discussed several recent developments which were in tune with the thrust of the main conference, making science education relevant to human needs. 'Education with production' was one response to this in which technology and applied science were emphasised through activities involving making and growing. Another approach was through the integration of science with other forms of learning, so that its study was part of a holistic study of the environment and mankind's response to it. In this latter model, ideas to be developed, and appropriate activities, would be identified in the cells of a matrix such as the following:

Science concepts relating to:	Social Aspects	Language	Maths	Art/Music Dance	Ethnics	Etc.
Light & Sight						
Sound & Hearing						
Movement & Forces						
Air & Breathing						
Water						
Soil						
Health						
etc.						

A further stage in this approach to programme construction was to envisage a third dimension, representing development in ideas from the very limited and concrete to the more general and abstract. The layers in the following diagram attempt to represent different levels in development of ideas and different complexity and foci of activities. The progress from one level to another would involve the asking, searching and productive thinking that characterises the type of learning discussed earlier in the workshop.



Providing a climate and a context for primary science

Document 13 expressed the kind of teaching and learning in science which was something of an ideal as

> 'helping children to develop ideas, not imposing ideas on them. But development depends on the children testing out their ideas against experience by observing, interpreting, hypothesising, raising questions, communicating — in short using all the process skills of science. When children work in this way they learn not only about the things around them but also that they *can* learn by doing thigs, by observing closely, by working out relationships, by reflecting on what they find. This can give them power in coming to terms with understanding the world around them, coupled with a growing responsibility for their own learning; it can help them grow into autonomous, thinking, people who will eventually take some responsibility for shaping their society as well as for technological and scientific advances.'
>
> UNESCO 1985, p.7

The problems of implementing this approach go beyond the need for new curriculum materials. Teachers require re-education of the kind that enables them to understand from experience the value of this kind of learning, to reflect on it and to become creative in pursuing it in their own classrooms. Document 13 expands on what is required and gives examples of in-service courses designed for this.

Change in school science requires more than change in teachers, however, for parents, school principals, inspectors, administrators and politicians all have their influence on what can be done in schools. Ways of communicating with these groups include

- inviting principals and inspectors to join in with teachers on in-service workshops,
- using the media where feasible and appropriate,
- bringing parents into schools to see children at work and running special session for parents,
- running workshops which extend the way of working to other subjects as appropriate,
- recognising the priority which is given to reading and number work in primary schools and displaying children's work which shows how science activities help this learning.

5. Looking to the Future

The workshop participants paid particular attention to the needs of developing countries in improving primary science education. These include help with

- equipment and materials supply,
- organising and attending meetings, courses and conferences to communicate good practice,
- updating materials for teachers and pupils,
- training key personnel,
- assessment methods which are consistent with good practice in science education,
- coping with 'syllabus overload' and the allocation of time for science,
- bringing about the wider changes in teacher/student relationships required as a context for the kind of learning proposed.

Can international bodies do more to help?

The work being carried out under the auspices of ICASE and UNESCO was outlined at the beginning of this report. The workshop participants, some being the providers and some the receivers of this support, were unanimous that it was the kind of thing that was essential for development in many third world countries. The following were picked out as areas where there was particular need for continued inputs from international bodies:

- advice to governments to review syllabuses and allow time for science and technology education to be pursued effectively,
- the collection and dissemination of information on assessment methods which would promote rather than inhibit good teaching and learning in science,
- meetings of those involved in constructing syllabuses so that implications for the curriculum of initiatives such as the Bangalore conference could be debated,
- provision of centres in each country through which UNESCO documents might be more effectively disseminated,
- development of more classroom materials and more teacher training materials,
- schemes which might be set up and operated through ICASE for more liaison between secondary science teachers and primary teachers.

Finally, at the conclusion it was agreed by all that more

workshops — and longer ones — of the kind experienced were much needed. It was important for those involved in the work, the school teachers the curriculum developers, researchers and teacher trainees to come to know each other better and to know about each others' problems. A few small steps were taken in Bangalore, but there is far to go on this journey.

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Appendix A

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Appendix B

The ICASE Supplementary Primary Science Programme

SCIENCE FOR LIFE

First Science

List of Topics for Student Explorations

1. The Water I Drink	— tiny organisms in the water
2. Drinking Safe Water	— killing organisms in drinking water
3. Water in Our World	— the water cycle
4. Where Do I Live	— my place on the Earth
5. Staying Healthy	— cleaning the openings in my body
6. Cleaning Around Us	— keeping my home, yard, and school clean
7. What I Eat	— three basic foods for good health
8. My House	— types of shelters
9. Saving Things Around	— conservation
10. Getting and Saving My Food	— producing and preserving food
11. Handling Waste Materials	— sanitation and waste handling
12. Which Way?	— directions, east, west, north, south
13. How Far?	— distances, close and far
14. Warm or Cold	— climate, weather
15. Life In My Home	— family life, health, cleanliness

Appendix C

Preservation of food in a Primary context: examples of primary activities suggested by the members of the Food and Agriculture group

'Keeping food' being a more understandable term for young children, a choice of questions — leading to experimental activities — was outlined:

- How do plants store food?

  (- in pods
  - in ears
  - in roots
  - in tubers)

  — For how long?

- What happens to foodstuffs if they are left around the classroom?

  Do just that and see that there is variety. Children can bring the materials from *home:* fruits, bread, rice, milk, leader, ... name it.

Things are bound to happen and outcomes can be observed (seen & smelled), discussed, recorded and ... a new question emerges:

- Can you do something so that these changes do *not* occur.

  Let children suggest what they like and try it out. (Mother's way will turn up and could be discussed and, of course, tried out:

  boiling
  drying
  smoking
  covering
  salting
  and others.)

- Somewhere one could focus onto a specific foodstuff or crop:

  e.g. maise (or beans, or rice, or other seeds)

Taken from different stores (homes of the children) children can ask themselves:

Which are good and which are not?

First observe carefully and see what you can find out.

Next test the seeds by germinating a hundred of them between damp newspaper or cloth.

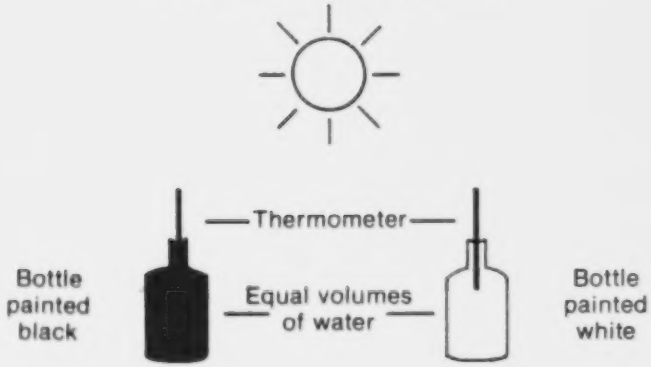
A hundred is a nice figure and leads to percentages. Good and bad seeds can be arranged side by side to form a natural box chart. Which of course, can also be produced on paper.

- What makes the bad seeds bad?

  ...time can be devoted to observing the work of weevils, flies, fungi, or whatnot.

Appendix D

A Typical Solar Energy Activity



Water in black bottle reaches a higher temperature than the water in the white bottle

END OF ACTIVITY

THE ACTIVITY HAS ONLY JUST STARTED!

Encourage the questions.

What would happen if ...

The bottles were painted on the inside?

The bottles were made of glass WITHOUT PAINT BUT CONTAINED WATER WITH BLACK DYE AND WHITE DYE?

The bottles were exposed to a non-luminescent heat source?

The bottles were different shapes? (e.g. two black bottles, same volume water, but quite different shapes).

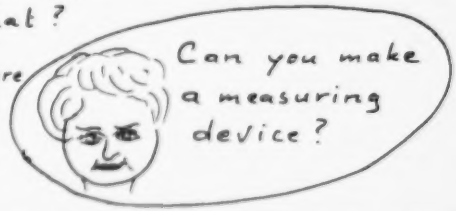
Students learn to:
- predict
- control variables
- record data
- interpret data

Make a Pendulum

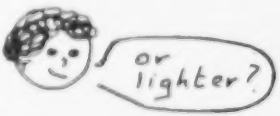
What does a pendulum do?

"This question is less simple as it looks. OK. It goes to and fro ... But where is "to"? And where is "fro"? What happens at "to"? and what at "fro"? What happens in between? Are "to" and "fro" at equal distance? From what?

How do you measure the movement of a pendulum?



Are the <u>times</u> (periods) between "to" and "fro" of equal length? And if you make the bob heavier?



How can you make a pendulum swing "faster" or "slower"

What exactly do you mean by "faster" or "slower"?

Let us name the movement "to" - "fro" a swing and "to" - "fro" - "to" a period

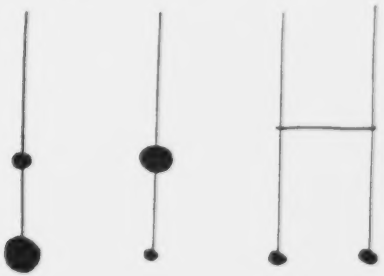
Can you make a pendulum with a "period" of 1 second?

Can you make a pendulum with a "swing" of one second?

Who can make the slowest pendulum in town?

Who can make the fastest

What happens when you swing these pendulums?



↓ try one at the time

A pendulum can make circles or elipses ... How?

How does this affect its "swing" or "period"

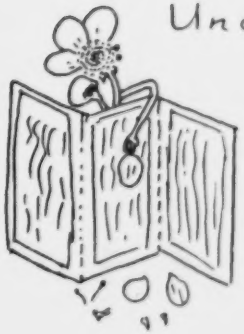
Keep asking

Flowers

Children can easily spot differences, but find it often difficult to indicate similarities.

An exercise like this one may help to overcome this problem:

Go out.
Each one in the group collects 5 different flowers: big and small
known and unknown
wild and cultivated
(If you have a small group, choose more.)



Undress your flowers carefully, and arrange the parts on a sheet of paper; make categories and place corresponding parts together.
Join the work of the whole group together.
Parts which are too small, may be examined through a lens and sketched on the paper.

To what questions (or answers) does this lead?

Ask...

Mimosa pudica

The plant which greets you with respect...

Many grow, small and humble, behind the sports building.

What happens when you touch the leaves?

Can you make half a leaf fold?

I want to try and make just one tiny leaflet fold

I can make two leaves fold up, not more

Where exactly do things fold?

How long does it "sleep"?

What happens when you give it a real hard kick?

Could you touch the plant so that it does not fold up?

Go on, keep asking!

ASK the Antlion

Who is the Antlion?

At the bottom of a humble, sandy pit lives the Antlion: - can you spot him?
- can you get him out?
Take a good magnified look... Sketch and describe him briefly ... so you recognise him again.

A waterdrop makes a good hand-lens.

What does a disturbed antlion do?
How does he move?
When does he start moving?
What happens when he finds sand?
Can he see? How can you find out?
How does he find sand?

What does he do in a shallow layer of sand? What in a deep layer?
Does coarse or fine make a difference?

Does he feel? Which part of the antlion is most sensitive?

How could you find out?

Touch me. I'll show you.

How does he catch ... what?

Ask the Antlion some more:

Where would you expect the antlion to live?

Go and find some.
Do not disturb them at first.
Drop an ant in a pit and watch what happens

How would the antlion make his pit?

Could you make an antlionpit yourself?

- Can you take them out of their pit?

- How does he make a new pit?
- Would he make a pit in other things than sand?
  - In sugar?
  - In flour?
  - In coarse sand?
  - In wet sand?
  - In sawdust?

Set up experimental situations. You probably will have to wait till the next day for any answer to your question

Can you now think of any problems of your own?

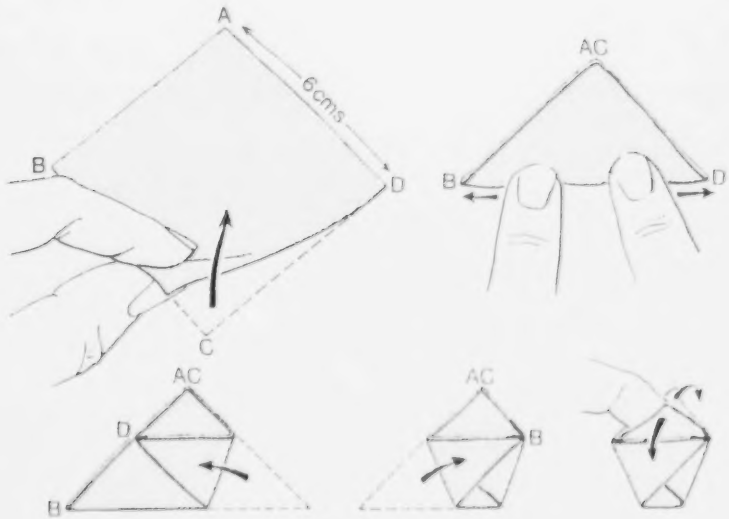
How would you then Ask the Antlion?

Appendix F

Origami and oral rehydration

A wide variety of methods has been suggested to measure the appropriate quanities of salt and sugar for oral rehydration. These include a two-ended spoon, a piece of wood with two holes in it, and versions made from bottle tops and local spoons.

One of us (B.Y.), who is involved with the CHILD-TO-CHILD programme and is presently writing a health education text for primary school teachers in developing countries, was concerned to find a simple way to present the idea in the classroom, to make it more "teachable". When his 12 year old son who had an interest in Origami was presented with the problem, he went away and returned with a paper cup. For the sugar, a piece of paper 6 cm square is needed; for the salt, an equivalent piece 3 cm square. It is made like this:



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To check that the container for the drink is the right volume, a cup made from paper 20 cm square can be used. *Two* of these make a suitable volume of 200 to 250 ml.

The idea has been tried out with 8 and 9 year old Mombasa school children. They had no difficulty in making the cups and thoroughly enjoyed learning a simple yet practical and useable idea.

Beverley Young, British Council
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Appendix G

PIED CROW

Kenya's Children's Health and Environment Magazine (CHEM)

Pied Crow (PC) is a very successful attempt at solving one of the most important problems of the developing world — educating young children about their health and environment. It is an example of what can be done very cost efficiently — with some funds but much more effort, creativity and persistence.

Under CARE funding it is now sent *free to all* Primary Schools in Kenya (50,000 copies each time), 6 times a year. Similar magazines are expected to soon be published in other countries in the local language. The chronology and expected development:

1982 Kenya in English Funded by NORAD, CARE-KENYA
1985 Indonesia in Bahasa funded by CARE-INDONESIA
1985 Uganda in English funded by CARE-UGANDA/UNICEF
1986 Honduras in Spanish funded by ?USAID/UNDP
1987 West Africa in French funded by ?UNESCO/EEC

Origin and Development:

The original concept was for a secondary school textbook for East African schools. After a feasibility study in the summer of 1982 by Dr. James V. Connor, representing the New York Zoological Society, the project changed its focus to an *informal* magazine for the upper primary schools (standards 6,7,8). The main reasons were three:

- The audience for environmental and health issues is much larger at the upper primary level;
- The formal curriculum would be very difficult to change in a short time; and
- The present teachers would not be equipped to teach a new curriculum without extensive training.

By writing the magazine *for children*, with special teacher pages, the awareness of both is raised and the material is being pilot tested at the same time.

NORAD funded a first issue in October, 1982. On the strength of its success, CARE-Kenya agreed to fund six similar issues each year for three years with Peter Hetz of the African Wildlife Foundation as Manager-Editor.

Goals:

Short term (1-5 years): To bring awareness of environment and health concerns of Kenya to children of the upper primary grades by using a magazine written for them (including teachers' pages).

Intermediate term (3-5 years): To have teachers use, evaluate and then create such materials for future magazine issues.

Long term (5 years —): To bring such topics into the *formal* curriculum and textbooks of Kenya's primary schools and teacher training colleges.

Evaluation:

Two years have now elapsed and thanks to a very favourable independent evaluation supported by the Ford Foundation, additional funds have been promised from several sources to increase the number of copies distributed.

The Ministries of Science, Education and Technology and of Environment and Natural Resources continue to strongly support this project. Ongoing approval of the materials and evaluation of their effectiveness have been guaranteed by the Inspectorate of the Ministry of Education.

Cost:

For 50,000 copies the cost to produce and print is US.$7,500 (about US.$.15 per copy).

Packaging and mailing in Kenya adds 50% to this cost.

Titles:

1. Save a Raindrop (Oct. 82)
2. Our Environment
3. Air and Water
4. Soil
5. Lets Start a Nursery
6. Planting Out
7. Energy
8. Road Safety
9. Bees
10. Wetlands
11. Where Are We Growing
12. Population and Water
13. Population and Land (Aug. 85)

14. Population and Forests
15. Population and Energy
16. Population and Cities & Employment
17. Population and Family Health

Larger Plan:

This magazine is intended to be part of a larger *information network* for environment and health materials directed at children, newly literate adults, etc. of developing countries through local newspapers, radio and television stations.

This magazine is also intended, with proper modifications, for use by newly literate adults and their children together in a family setting, by extension workers, various NGO groups, etc.

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